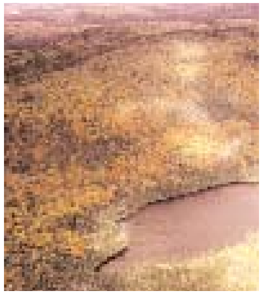
Issue Summary

A Yale Forest Forum Series Publication

Volume 6 Number 1

2003

YFF Review



New Threats to North American Forests

A summary of a forum and workshop exploring the impact of Asian Longhorned Beetle and Emerald Ash Borer on forests and forest-based economies

A Yale Forest Forum Event

February 27, 2003

Global Institute of Sustainable Forestry

New Haven, Connecticut

"Because Asian Longhorned Beetle exhibits different behaviors at different times of the year, there is a strong seasonal component to monitoring strategies."

— Michael Smith

Michael T. Smith
Research Entomologist, USDA Agricultural Research Service Beneficial Insect Introduction Research Unit

The Beneficial Insects Introduction Research Unit has conducted extensive research in Northern China on the life history and behavioral aspects of Asian Longhorned Beetle (ALB). The goal of this research is to identify the main factors that influence ALB populations and to develop models for predicting their spread, which in turn can help forest managers formulate strategies for dealing with the beetle in ecosystems like the North American hardwood forests.

Successful development of predictive models requires an understanding of the influence that biotic and abiotic factors have on behavioral and population parameter characteristics. In the case of ALB, the biotic factors pertained to the beetle itself—insect age, gender, size, and egg load—in addition to its preferred hosts—tree species, health, size, and branching and canopy structure. Abiotic factors included temperature, relative humidity, wind speed and direction, cloud cover, time of day, precipitation, and landscape features.

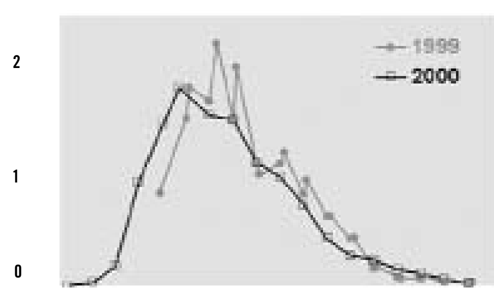
Adult beetle behavior can be broken down into at least six different categories: emergence, when the adult beetle makes its way towards the surface of a tree and chews a sub-surface gallery as it matures; feeding, when the beetle exits the tree and feeds on exterior plant tissues; mating, when beetles—particularly males—seek, guard, and often steal mating partners; oviposition, when female beetles chew holes in the bark of host trees and lay a single egg in each hole; resting, which in part is a behavioral manifestation of thermoregulation; and colonization/re-colonization, when beetles either remain on their current host tree or seek a new host, depending on host quality and population density. The nutritional differences between various host tree species may affect some of these behaviors. For instance, female beetles lay more eggs and live longer when feeding on Norway maple compared to red maple or black willow, and ALB larvae experience the most weight gain when feeding on Norway maple. Therefore, the tissues on which ALB feed may influence their reproductive potential and behavior.

Complementary field experiments were used to assess the dispersal potential of ALB, including measures of both flight propensity (the tendency to take flight) and flight capacity (flight distance). First, mass-mark recapture studies examined population spread over the course of an entire season and on a large spatial scale. Then tracking studies examined individual beetle movement on a daily basis and on a smaller spatial scale. These were followed by flight studies which were used to assess the flight capacity of individual beetles that were released from captivity. Lastly, two year-long resident density and emergence studies measured the resident time of beetles emerging from a given tree and their propensity to remain or depart for a new host.

These studies provided a comprehensive picture of the characteristics of ALB movement. Flight patterns differed by gender, with females traveling an average of 27.5 meters per day and males 32.4 meters per day, although the beetles did demonstrate the ability to move over a kilometer in a day depending on landscape and time of year. The average dispersal over an entire season was approximately 223 meters, with a maximum season-long movement of 2.4 and 2.6 kilometers for males and gravid females, respectively. During epidemic conditions of high population density, flight propensity from a given host tree was 81 percent, most likely resulting from diminished host tree quality. Therefore, flight propensity is directly proportional to population density and inversely proportional to host quality.

In-flight orientation studies provided a more detailed portrait of ALB flight behavior. In initial studies where beetles were released from captivity, beetles demonstrated a clear preference for landing on trees rather than other landscape features, and for shaded rather than sunlit areas. While these beetles showed no preference for landing on host trees versus non-host trees, it was clear that their long-range host orientation is based, at least in part, on visually tracking trees. In subsequent studies where the relative attraction of different tree species were evaluated by placing them adjacent to naturally infested poplar trees, it was demonstrated that ALB can differentiate tree species at close-range, as well as trees under differing levels of stress. It was also demonstrated that close-range orientation is influenced by abiotic factors such as time of day and wind speed: about three times as many beetles made directed flights and landings on sentinel trees in the late afternoon than in the early morning, and their ability to orient, take flight, and land on trees became greatly diminished once wind speeds exceeded eight miles per hour.

While there are many different tree species in China, relatively few of them are actually attacked and infested by ALB. This is true even within tree genera known to contain species commonly attacked by ALB, suggesting that some tree species are resistant to ALB. For instance, while the primary host trees attacked by ALB in China are in the genus Populus, some Populus species are not attacked. In other Populus species into which ALB oviposit, ALB eggs and early instar larvae are reported to be killed as a result of water pressure. Similarly, while Ulmus species are another common host for ALB, female beetles are reported to chew ovipositional pits in some Ulmus species but fail to lay eggs. Finally, within some Tilia species, ALB eggs are laid and larvae hatch, but larvae die before reaching the sapwood.



Seasonality of Asian Longhorned Beetle in China.
Average number of beetles per tree from May 30 to September 27.

Monitoring strategies for ALB should be optimized based on what is known about beetle behavior. Visual indicators of the presence of ALB include: (1) dime-sized circular exit holes and oval to round egg sites which may be present along the trunk and branches; (2) adult feeding damage in which: (a) the outer bark/tissue layer is eaten off of twigs and leaf petioles, (b) the main leaf veins or inter-vein leaf tissues are consumed, thereby leaving irregular shaped holes in leaves, and (c) leaves fall prematurely as a result of feeding on leaf petioles; (3) frass accumulated in branch crotches or at the base of trees; and (4) sap bleeding from oviposition sites and larval galleries. It is important to note that exit holes and oviposition sites may occur from the base of trees to high in the canopy depending, in part, upon bark thickness. For example, young thin barked trees may have signs of attack at or near ground level along the trunk, while such signs are more typically higher along the trunk and branches in more mature or thick barked trees.

Because ALB exhibits different behaviors at different times of the year, there is a strong seasonal component to monitoring strategies. As such, monitoring for adult beetles, feeding damage, and oozing sap should be concentrated during July and August, the peak period of adult abundance. More specifically, recent studies have shown that peak population abundance occurs 800 to 900 degree days (base threshold = 10 ºC) from the first of January. Monitoring for exit holes and oviposition sites should occur after leaf fall, since these signs are more visible at that time. Spatial studies of ALB behavior and population abundance suggest that monitoring efforts should be concentrated on preferred host trees, particularly solitary individuals, and along edges in plantations, forests, windbreaks and urban landscapes. These guidelines should assist in optimizing monitoring efforts to alert managers to the presence of an infestation.

Ultimately, an understanding of species richness, diversity, host quality and health will be the basis for predicting how Asian Longhorned Beetle might spread in North America.